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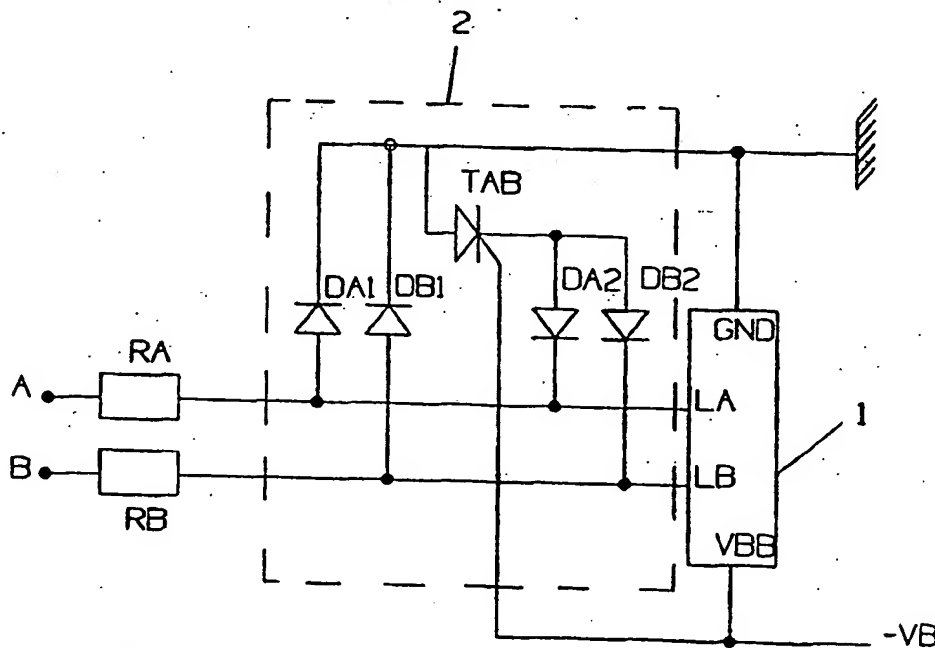
## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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(54) Title: AN APPARATUS FOR PROTECTING A SUBSCRIBER LINE INTERFACE CIRCUIT AGAINST OVERVOLTAGES

## (57) Abstract

An apparatus for protecting a subscriber line interface circuit (1) against overvoltages occurring on its two input wires (A, B) and exceeding the voltage of the supply voltage source of the subscriber line interface circuit (1). A resistor (RA, RB) is connected in series with a respective input wire (A, B) to respective input terminals (LA, LB) of the subscriber line interface circuit. Each input terminal (LA, LB) is connected to the anode of a respective first diode (DA1, DB1), whose cathode is connected to the positive terminal of the supply voltage source, and also to the cathode of a respective second diode (DA2, DB2). The anodes of the second diodes are connected to the cathode of a thyristor (TAB) which is common to the second diodes. The anode of the thyristor is connected to the positive terminal of the supply voltage source and the gate of the thyristor is connected to the negative terminal of the supply voltage source.



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An apparatus for protecting a subscriber line interface circuit against overvoltages

#### TECHNICAL FIELD

The present invention relates to apparatus for protecting a subscriber line interface circuit against overvoltages appearing on its two input wires and exceeding the voltage of the supply voltage source of the subscriber line interface circuit.

#### BACKGROUND ART

10 It is known to protect subscriber line interface circuits against overvoltages, primarily against overvoltages in the form of lightening-induced overvoltage pulses caused, with the aid of a so-called primary protector which may, for instance, consist in a spark gap which functions to reduce the overvoltages on the subscriber line to a voltage of about one kilovolt. A so-called secondary overvoltage protector is fitted to the subscriber line, to deal with these residual pulses of about one kilovolt. The secondary overvoltage protector may have the form of a known circuit marketed by General Semiconductor under the trademark TRANSZORB, or a circuit marketed by RCA under the trademark SURGECTOR.

Current standards require the secondary overvoltage protector to be earthed to the apparatus stand with a separate wire. However, this can create problems that are manifested in the form of residual pulses in the order of magnitude of some hundred volts across a subscriber line interface circuit connected to the subscriber line. Modern line interface boards, in which the line interface circuit is a monolithic integrated circuit, are very often broken-down by lightening, due to residual pulses from the secondary overvoltage protector appearing across the two input wires of the circuit board.

US-A 4,456,940 teaches an overvoltage protector which includes, among other things, two diodes whose anodes are each connected to a respective input terminal of a subscriber line interface circuit and whose cathodes are connected to earth, and further includes two thyristors whose cathodes are each connected to a respective input terminal on the subscriber line interface circuit and whose anodes are connected to earth. The thyristor gates are connected to the supply voltage of the subscriber line interface circuit. This protective circuit protects the subscriber line interface circuit against overvoltages. However, the thyristors are relatively space-consuming and a reduction in their number would be a significant advantage. It is sometimes necessary to match the thyristors, so that they will ignite or fire simultaneously, i.e. for the same voltage across the cathodes with equal voltage across the gate. However, the document does not describe several cascade-connected overvoltage protectors.

#### SUMMARY OF THE INVENTION

The object of the invention is to eliminate the effect on a subscriber line interface circuit of residual pulses that emanate from secondary overvoltage protectors.

This object is achieved with apparatus according to the invention and having the characteristic features set forth in the following Claims.

One advantage afforded by the present invention is that the number of thyristors required in the tertiary overvoltage protector has been reduced in comparison with the number required in the known protectors, therewith reducing the space required by the overvoltage protector. Another advantage is that matching between two or more thyristors to ensure that the thyristors will be activated at one and the same voltage level is no longer necessary.

**BRIEF DESCRIPTION OF THE DRAWING**

The invention will now be described in more detail with reference to the accompanying drawing, in which Fig. 1 is a block schematic which illustrates a primary overvoltage protector circuit, a secondary overvoltage protector circuit and a tertiary overvoltage protector circuit connected to a subscriber line interface circuit; and Fig. 2 illustrates an embodiment of a tertiary overvoltage protector circuit according to the invention for a subscriber line interface circuit.

**BEST MODE OF CARRYING OUT THE INVENTION**

Fig. 1 is a block schematic illustrating an inventive total overvoltage protector for a subscriber line interface circuit 1. The subscriber line interface circuit 1 has its input terminals LA and LB connected to a pair of outlet terminals 5, 6 on a tertiary overvoltage protector 2. The tertiary overvoltage protector 2 has two input terminals 7, 8 connected in cascade to two output terminals 9, 10 of a secondary overvoltage protector 3, which in turn has two input terminals 11, 12 connected in cascade to two output terminals 13, 14 of a primary overvoltage protector 4. The primary overvoltage protector 4 has two input terminals 15, 16, each of which is connected to a respective resistor RA and RB, the resistances of which are normally in the order of 10 ohms and each of which is connected to a respective input wire A and B of the subscriber line interface circuit 1. The primary overvoltage protector 4 is normally of a known kind, i.e. a spark gap, and the secondary overvoltage protector 3 is normally of a known kind, such as the kind designated TRANSZORB or SURGECTOR. As shown in the Figure, the tertiary overvoltage protector 2 and the subscriber line interface circuit 1 are connected to system earth, whereas the secondary overvoltage protector 3 is connected to apparatus earth.

Overvoltage pulses that are caused by lightening for instance, and which occur on the two input wires A and B of the circuit 1 are reduced by the primary protector 4 to residual pulses in the order of one kilovolt, these residual pulses being reduced to the order of some hundred volts by the secondary overvoltage protector. These residual pulses arriving from the secondary protector 3 and having a voltage level which exceeds the supply voltage to the subscriber line interface circuit are eliminated by the tertiary overvoltage protector 2.

10 The inventive tertiary overvoltage protector 2 is shown in broken lines in Fig. 2. The secondary and primary overvoltage protectors have been omitted from the Fig. 2 illustration, and the tertiary overvoltage protector 2 is shown connected directly to the resistors RA and RB. The input terminals LA, 15 LB of the subscriber line interface circuit 1 are each connected to the anode of a respective first diode DA1, DB1, the cathodes of which first diodes are connected to system earth. The input terminals LA and LB are also each connected to the cathode of a respective second diode DA2 and DB2, 20 wherein the anodes of the second diodes are connected to the cathode of a thyristor TAB which is common to said second diodes and the anode of which is connected to system earth and the gate of which is connected to a connection terminal on the voltage-supply source of the interface circuit 1, said supply 25 voltage source having the potential -VB. The tertiary overvoltage protector 2 thus includes the first diodes DA1 and DB1, the second diodes DA2 and DB2 and the thyristor TAB.

The subscriber line interface circuit 1 is supplied between earth and the voltage -VB, which is normally -50V. The input 30 terminals GND and VBB of the subscriber line interface circuit 1 are therefore connected to system earth and the potential -VB respectively.

Occurring overvoltages will be restricted in the following manner:

Positive overvoltages are restricted with the aid of the diodes DA1, DB1, whereas negative overvoltages are restricted to about 2V beneath -VB, in other words more negative than -VB, where 2V corresponds to the sum of the forward voltage drop of respective diodes DA2, DB2 and the forward voltage drop across the gate for turning on the thyristor TAB. The input terminals LA, LB are drawn to earth when the thyristor TAB ignites.

The inventive protective circuit is thus effective in eliminating the problem associated with the breakdown of subscriber line interface circuits that are subjected to lightning induced overvoltage pulses.



## CLAIMS

1. Apparatus for protecting a subscriber line interface circuit (1) against overvoltages occurring on its two input wires (A, B) and exceeding the voltage of the supply voltage source of the subscriber line interface circuit (1), wherein a resistor (RA, RB) is connected in series with a respective input wire (A, B) to a respective input terminal (LA, LB) of the subscriber interface circuit, wherein each input terminal (LA, LB) is connected to the anode of a respective first diode (DA1, DB1), and wherein the cathodes of the first diodes are connected to the positive terminal of the supply voltage source, characterized in that each input terminal (LA, LB) is also connected to the cathode of a respective second diode (DA2, DB2); in that the anodes of said second diodes are connected to the cathode of a thyristor (TAB) which is common to the second diodes; in that the anode of the thyristor is connected to the positive terminal of the supply voltage source and the gate of said thyristor is connected to the negative terminal of said supply voltage source.
2. Apparatus for protecting a subscriber line interface circuit (1) against overvoltages that occur on its two input wires (A, B) and that exceed the voltage of the supply voltage source of said subscriber line interface circuit (1), wherein a resistor (RA, RB) is connected in series with a respective input wire (A, B) to a respective input terminal (15, 16) on a primary overvoltage protector (4) which is connected in cascade to a secondary overvoltage protector (3) which is connected in cascade to a tertiary overvoltage protector (2) which is connected in cascade to the subscriber line interface circuit, wherein the secondary overvoltage protector is connected to apparatus earth and the tertiary overvoltage protector includes a first diode (DA1, DB1) for each input wire, wherein respective input terminals (LA, LB) of the subscriber line interface circuit are connected to the anode

of respective first diodes (DA1, DB1) and wherein the cathodes of the first diodes are connected to the positive terminal of the supply voltage source, characterized in that the tertiary overvoltage protector (2) also includes a thyristor (TAB) and  
5 a second diode (DA2, DB2) for each input wire (A, B), wherein respective input terminals (LA, LB) of the subscriber line interface circuit (1) are also connected to the cathode of a respective second diode (DA2, DB2), wherein the anodes of the second diodes are connected to the cathode of the thyristor,  
10 the anode of which is connected to the positive terminal of the supply voltage source and the gate of which is connected to the negative terminal of the supply voltage source.

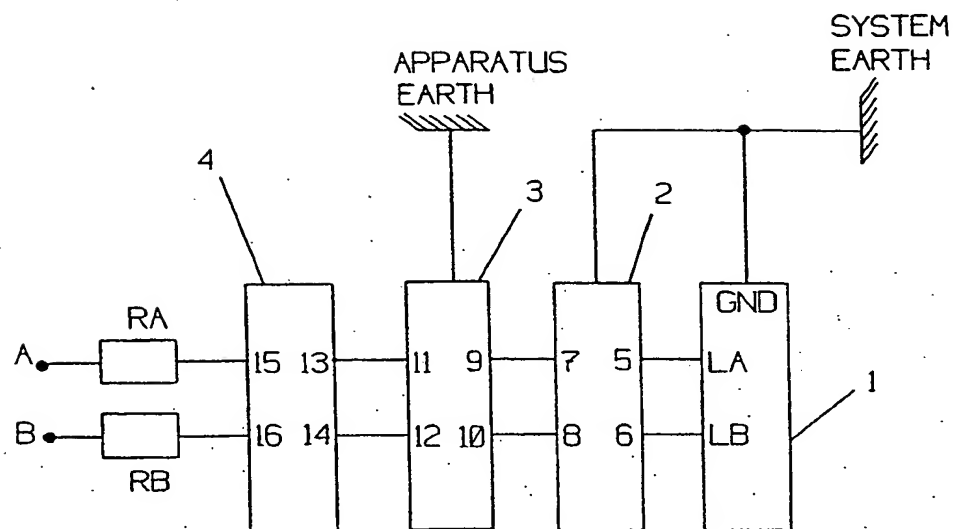


FIG. 1

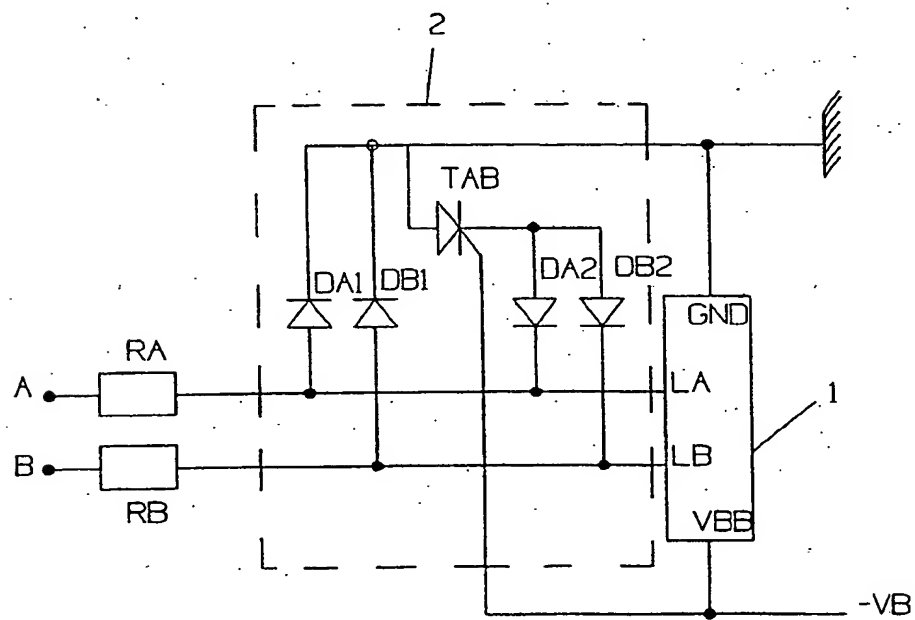


FIG. 2

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 95/00800

## A. CLASSIFICATION OF SUBJECT MATTER

IPC6: H04M 3/18, H02H 9/04

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: H04M, H02H

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4908854 A (BENGT G. LÖFMARK), 13 March 1990 (13.03.90), column 2, line 42 - line 66, figure 1 --	1-2
A	US 4377832 A (JOHN J TONEY ET AL), 22 March 1983 (22.03.83), column 2, line 37 - column 3, line 40, figures 1-2, abstract --	1-2
A	US 4456940 A (LARS E. HAMMERBERG ET AL), 26 June 1984 (26.06.84), column 2, line 26 - line 40; column 2, line 52 - column 4, line 12, figures 1,4,5, abstract --	1-2



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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5003588 A (NORBERT WINGERATH), 26 March 1991 (26.03.91), figures 1-2, abstract  -----	1-2

**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
US-A-	4908854	13/03/90	AU-B-	604383	13/12/90
			AU-A-	2533788	02/05/89
			CN-A-	1032610	26/04/89
			DE-A-	3868478	26/03/92
			DK-B-	168316	07/03/94
			EP-A,B-	0311580	12/04/89
			IE-B-	61777	30/11/94
			JP-T-	2501525	24/05/90
			SE-B,C-	459138	05/06/89
			SE-A-	8703890	09/04/89
			WO-A-	8903625	20/04/89
US-A-	4377832	22/03/83	NONE		
US-A-	4456940	26/06/84	AU-B-	547598	24/10/85
			AU-A-	7934082	20/07/82
			EP-A,B-	0067839	29/12/82
			SE-B,C-	426002	29/11/82
			SE-A-	8009142	24/06/82
			SU-A,A-	1258339	15/09/86
US-A-	5003588	26/03/91	WO-A-	8202287	08/07/82
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